NOAA Technical Memorandum ERL ESG-12

A SUMMARY OF METEOROLOGICAL PRODUCT USAGE DURING THE PROFS CONVECTION FORECAST EXERCISE OF 1983

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DURING THE PROFS CONVECTION FORECAST EXERCISE OF 1983

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ABSTRACT. During the summer of 1983 the Program for Regional Observing and Forecasting Services (PROFS) conducted its third convective season forecast exercise. One hundred and eight meteorological products including satellite and radar imagery, displays of data in contour and streamline formats, and plots of surface and upper air data were available to the forecasters on the PROFS workstation. Each product was available on one of four scales, each scale covering a specific, successively smaller, geographic area. Throughout the exercise a record was kept of the number of times each product was selected by the workstation forecasters. Examination of the resulting product usage patterns reveals high use of image products and a preference for plotted observations over contour and streamline products. Products on the local scale were the most often used. Forecasters relied most heavily on satellite and radar imagery in thunderstorm forecasting, especially during the 10 minutes prior to issuing warnings. Overall, the single most often selected product was a plot of local-scale surface observations. The high use of the image products suggests that they provide the forecaster with essential information not otherwise available. The fact that the mesonet plot was the most often called product indicates that quantitative information is needed to verify the presence of the physical processes suggested by the imagery. Finally, the 1983 product usage patterns indicate that consideration of data requirements for future convective-scale exercises, experimental or operational, necessarily requires consideration of future computing resources and limitations.

1. INTRODUCTION

During the summer of 1983, the Program for Regional Observing and Forecasting Services (PROFS) conducted its third convective season forecast exercise (McCoy, 1985; Schlatter et al., 1985). The participants included 24 operational and research meteorologists, working a total of 12 forecast days each. For this exercise, 108 meteorological products, displayed on one of four map projections, were available to the forecasters on the PROFS workstation. Forecasters selected products for display from menus on a touch screen by touching the appropriate product selector on the screen. A record of these "touches," or product calls, along with the times the products were selected, was kept during all operational hours of the exercise.

This record gives the total number of times each product was selected for display during the exercise. Not included, however, are the products forecasters used to prepare the day's convective outlook, as only the FAX satellite, surface observations, Denver sounding, and the National Meteorological Center (NMC) products accessed via AFOS (Automation of Field Operations and Services) were available for that task. Otherwise, all products used after the convective outlook was issued are reflected here; the tally includes the product usage for surveillance, warnings, and regularly scheduled point forecasts.

In this paper we will look first at the overall product usage patterns of the workstation forecasters, and then examine the product usage during warning, point forecast, and surveillance situations. We will examine the products selected during the 10-minute period prior to the time a severe thunderstorm, tornado, or flash flood warning was issued. Next, we will look at the products forecasters preferred when issuing point forecasts of precipitation and winds. Finally, we will examine the products used for surveillance, which is assumed to be the main activity when warnings and point forecasts are not under consideration.

2. THE PRODUCT SCALES AND PRODUCT UPDATE FREQUENCY

Each product was available on one of four scales, each covering a fixed geographical area in a specific map projection. Beginning with the national scale, the areas were progressively smaller through the regional, eastern Colorado, and local scales.

National Scale (Fig. 1). This was the largest of the four scales, covering the contiguous 48 states and coastal waters, mapped in polar stereographic projection. This projection was chosen because a large number of NMC graphics received over the AFOS system were reformatted for display on the PROFS system. Rather than remap all the NMC products to the satellite projection each time a new satellite image was received, it was more efficient to remap the satellite image to the polar stereographic projection of the NMC products, better utilizing computer resources. Locally generated plots of rawinsonde data were also available on this scale.

Regional Scale (Fig. 2). This projection covered approximately 1000 km^2, or about five western states, centered on Denver. Products on this scale were displayed in the GOES-East or GOES-West satellite projection, in a size that corresponds to half-resolution GOES data. The regional-scale products were streamlines, contours, and plots of surface observations, and visible and IR satellite images.

Eastern Colorado Scale (Fig. 3). The eastern Colorado scale covered an area 540 by 600 km, roughly two-thirds of Colorado and small portions of neighboring states. Products on the eastern Colorado scale were displayed in a Lambert conformal projection. An important consideration in choosing this projection was that it introduces a minimum of scale variation across the map. As a result, radar data displayed on this scale may be converted from the original polar coordinates to a simple x-y plane as opposed to a more complex geometrical surface. The radar product available on this scale was a mosaic image of the Limon, Colorado (LIC) and the Cheyenne, Wyoming (CYS) National Weather Service (NWS) radar plan position indicators (PPIs). Other products on the eastern Colorado scale were remapped visible and IR satellite imagery, plots of lightning data and surface reports, and several contour and streamline products.

Local Scale (Fig. 4). This was the smallest scale, an area about 300 km square, located mostly in northeastern Colorado and encompassing the 150 km range of the CP-2 radar leased from the National Center for Atmospheric Research. Local-scale products were also displayed in a Lambert conformal projection, for the same reasons as were the eastern Colorado-scale products. The products available on this scale included low-level reflectivity and Doppler velocity from the CP-2 radar, plots and streamlines of data from the PROFS 22-station automated mesonet (Pratte and Clark, 1983), lightning data, and, when available, rapid-scan visible and IR satellite images. Two vertical products, the Denver RAOB and the profiler skew-t plots were available, as well as plots of the Urban Drainage District (UDD) precipitation and stream height data. All forecasts and warnings issued were for the local-scale area.

Product update frequency, the time interval between updates of the product, ranged from a maximum of 12 hours for many of the NMC products to a minimum of 5 minutes for most of the local-scale products. Generally, the product frequencies varied by product scale; larger scale products were updated less frequently than products on the smaller scales (Table 1).

3. PRODUCT USAGE SUMMARY

3.1. Overall Statistics

National-scale product calls accounted for only 8 percent of all product requests, reflecting the mesoscale nature of the exercise. National-scale products were primarily called while the forecaster's conceptual model of the day was being formulated at the beginning of the forecast shift, and only infrequently thereafter. The only image available on this scale, the remapped infrared satellite image, was also the most frequently displayed national-scale product (22 percent of calls to products on this scale). Use of other national-scale products was significantly less; the 500-mb plot, for example, was called only 34 times during the exercise.

Fifty NMC products were also available, accounting for 5 percent of the total product selections. Of these, the radar echoes was the most often requested.

The use of regional-scale products constituted 10 percent of all product requests. There were 762 requests for the visible satellite image, which represents about 41 percent of all regional-scale product usage. Use of the other regional-scale products was much lower. The display of plotted SAO data, usually overlaid on the visible satellite image, was the second most requested

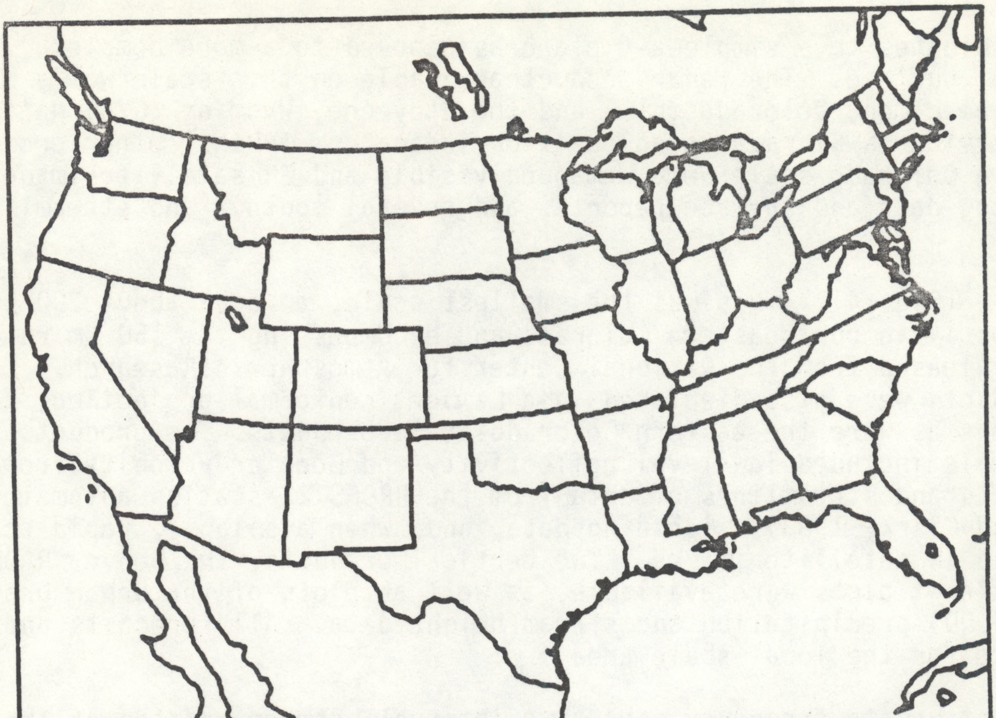

Figure 1. National-scale display area.

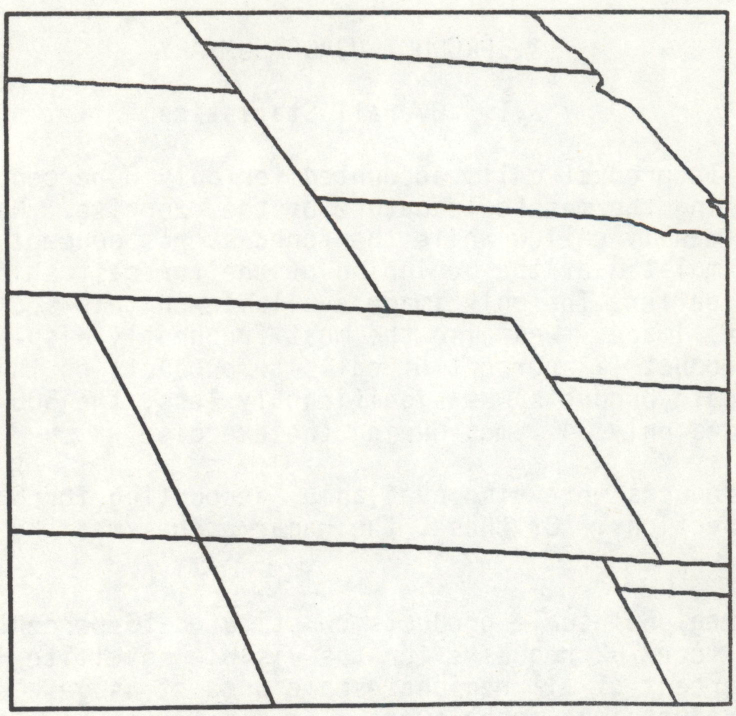

Figure 2. Typical regional-scale display area centered on Denver and showing most of the central Rocky Mountain states.

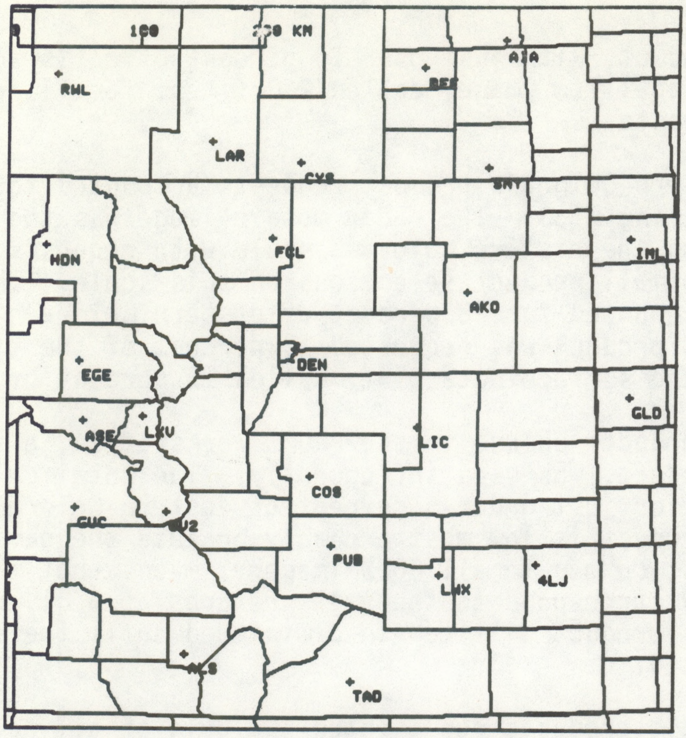

Figure 3. Eastern Colorado-scale display area. National Weather Service (NWS) observing stations are identified by their 3-letter abbreviations. County boundaries are shown.

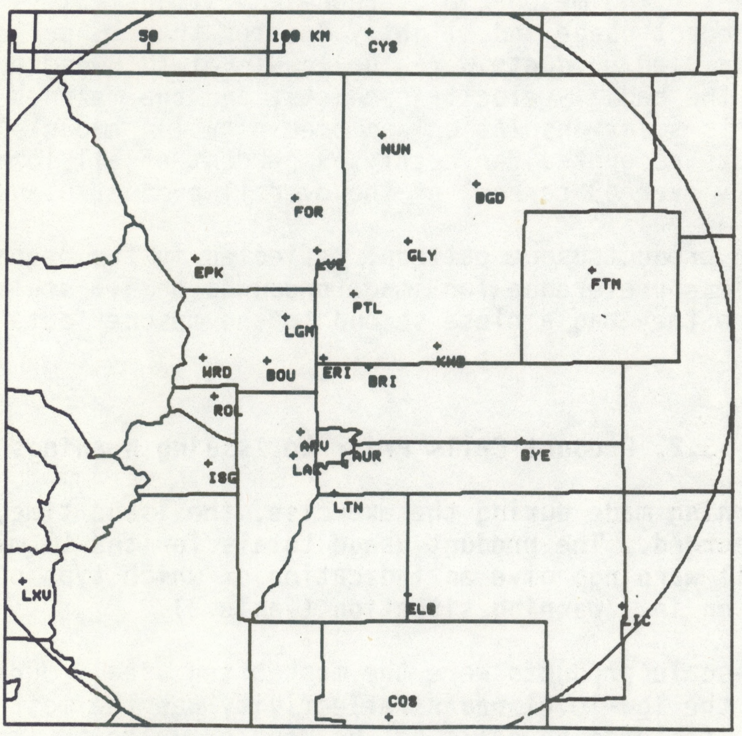

Figure 4. Local-scale display area. NWS observing stations and PROFS mesonet stations are identified by their 3-letter abbreviations. CYS, COS, LIC, and LXV are NWS stations; the others are mesonet stations. County boundaries are shown.

regional-scale product, with just over 16 percent of calls on this scale. Third was the infrared satellite image, called 260 times, for 14 percent of regional-scale product requests.

Overall, eastern Colorado product requests accounted for 19 percent of the total calls during RT83. The radar mosaic image was the most frequently selected product on the eastern Colorado scale with requests accounting for just under 34 percent of all product selections on this scale. The remapped visible satellite image accounted for 23 percent of eastern Colorado product calls, and the lightning plot product was requested 13 percent of the time. Another often-used product was the surface data plot, called 11 percent of the time.

One of the products unique to the PROFS workstation, a satellite and radar combined image product, was used infrequently. The total calls for this product accounted for just under 5 percent of eastern Colorado product calls. The use of this product is low most probably because the navigation error of several kilometers, common to all GOES imagery, means that the satellite returns do not necessarily correspond to the radar returns at a given location. The usefulness of this product will remain diminished until the satellite navigation problem is corrected.

The local-scale products represented the bulk of all requests with 63 percent of all selections. The products on this scale allow the forecaster to survey the pre-convective environment, to monitor and track thunderstorms once they form, and to forecast and warn on these storms.

The mesonet plot was the most often requested of all products during RT83. The 3150 requests for the mesonet plot represent slightly less than 26 percent of local-scale product usage and slightly greater than 16 percent of all calls. Other very heavily used products were the low-level (0.5-degree elevation) reflectivity and the radial velocity products, and the mesonet sky parameters plot (which reports solar insolation and precipitation amounts). Together, these four products accounted for nearly 69 percent of all local-scale product calls and slightly over 43 percent of the overall product usage.

The emerging product usage pattern, reflected in the overall product calls, shows a clear preference for image products on all scales except on the local scale, where they ran a close second to the mesonet data plot (Table 2).

3.2. Product Calls Prior to Issuing Warnings

For each warning made during the exercise, the issue time, start time, and duration were recorded. The product usage totals for the 10 minutes preceding issue time for all warnings give an indication of which type of information forecasters rely on in a warning situation (Table 3).

Again local-scale products were the most often used. During this 10-minute period the low-level radar reflectivity was the most frequently selected product, followed by calls to the Doppler velocity product and the mesonet plot. Together, these three products were selected 367 times, nearly two-thirds of all calls made during this period. Use of other local-scale products during this time was considerably less than these three. For example, the mid-level reflectivity, the local-scale lightning plot, and the mesonet streamlines together were called only 83 times.

The relatively low use of the mid-level reflectivity may be at least partially due to its frequent lateness or unavailability. And while the lightning plot, the mesonet plot, and the streamline products usage was high in the overall totals, their lower usage in the warning situation may be due to the fact that in the 10-minute period prior to issuing a warning, the forecaster is concentrating on diagnosis and nowcasting, and is not looking at products that provide more surveillance or pre-convection information.

The 90 eastern Colorado-scale product calls accounted for 15 percent of all product selections made during this 10-minute period. The radar mosaic image was the most often used (33 requests), followed by the visible satellite image and the lightning plot product.

The only national-scale products used during this time were the NMC products, and those were used only minimally. The 14 calls to these products were only 2 percent of all product requests made within 10 minutes before a warning was issued. Regional-scale product use was slightly greater than that of national-scale products, but was still only 3 percent of the total product calls during this period. Of these, the most often-requested product was the visible satellite image.

It is important to note that the relatively low use of satellite data before warnings were issued may well be due to the infrequency of the image transmissions. The eastern Colorado- and regional-scale satellite images were updated only every 30 minutes, and the national-scale image only once every hour. However, on 4 days during the exercise, the satellite was being operated in research rapid-scan mode, and satellite data were available every 5 minutes. A look at product calls made on those 4 days during the 10 minutes before a warning was issued shows that the 5-minute satellite images were called considerably more often than the 30-minute satellite images, and almost as much as the mesonet plot and the radar reflectivity and velocity products. With a sample size of only 4 days it is impossible to know how much the forecasters would have used the rapid-scan data had it been regularly available during the exercise, but forecaster comments about the high-frequency imagery were very favorable (Schlatter et al., 1985), especially in regard to their potential benefit in situations where convection is just beginning, well before echoes appear in the radar data.

3.3. Product Calls Prior to Issuing Point Forecasts of Precipitation and Wind

Forecasters were also required to issue an hourly point forecast of precipitation and wind, alternating between the two, precipitation on even hours and wind on odd. The forecasts were valid for a 2-hour period and were issued 15 minutes before their valid times. By looking at the product calls made in the

10 minutes before the forecasts were made (Table 4), it is possible to determine which products participants were using to make their forecasts. With only one minor exception, the product usage pattern for making precipitation and wind forecasts follows that of overall product use, that is, a preference for the image products and the mesonet data plot product. The one exception is that on the national scale the NMC weather depiction product was used more often before a precipitation forecast was issued, while the NMC radar echoes product was called more often in all other situations.

3.4. Surveillance Product Calls

The usage pattern for surveillance product calls, product requests made at times other than just before warnings or point forecasts were issued, follows the patterns established for overall product usage and for point forecast usage (Table 5). Most calls were to local-scale products; collectively these products accounted for 60 percent of all surveillance product calls. As in the other situations, the mesonet plot, the low-level radar reflectivity, and the radar velocity products were the three most often called on the local scale.

Eastern Colorado, regional, and national-scale products represented 19 percent, 10 percent, and 9 percent respectively, of all surveillance product requests. The most often requested product on the eastern Colorado scale was the radar mosaic image. The visible satellite image and the infrared satellite image were the most used on the regional and national scales, respectively.

4. CONCLUSIONS AND DISCUSSION

The dominant features of the product usage patterns are the high use of image products and the preference for plotted observations over objectively analyzed contour and streamline products. While forecasters used the mesonet data plot most often overall, they relied most heavily on satellite and radar imagery in thunderstorm forecasting: the 16 image products accounted for 49 percent of all selections. This is especially true in preparation of warnings where the radar velocity and reflectivity displays were chosen more often than the mesonet plot. The summary statistics also illustrate the relatively heavy use of a small number of products: 17 of the 108 products accounted for 65 percent of all product calls. We offer the following as a brief explanation of this pattern.

Perhaps more than any other group of products, the image products best utilize the human facility for pattern recognition and at the same time offer the forecaster a multi-dimensional view of current and developing storms. These two characteristics of imagery account for the consistent and frequent use of the image products during the RT83 exercise. Forecasting convective-scale phenomena is not entirely a matter of pattern recognition, however, as evidenced by the very high use of the local-scale mesonet data plot.

While the large-scale observing network is adequate to resolve significant synoptic scale features such as mid-latitude cyclones, fronts, jet stream fluctuations, etc., it is too coarse to detect significant small-scale convective phenomena such as gust fronts or their parent thunderstorms. As the scale of interest decreases, the large-scale observing network becomes less useful as a source of information to the forecaster. Image products provide valuable supplemental information. Even on the large scale where the data plots provide quantitative information adequate to resolve synoptic-scale features, satellite imagery shows phenomena that are impossible to see in plots or in contours. And, as the scale of interest decreases, the need for the information provided by the image products increases. For example, satellite imagery displayed on the intermediate scales can reveal evidence of convection that cannot be seen in the other products, often before it has grown large enough to be seen by radar. On the small scale, radar imagery allows the forecaster to view both the horizontal and vertical structure of existing and developing storms. These perspectives cannot be obtained from other kinds of displays.

Further, the image products also provide information about the geometrical structure of the storms. An experienced forecaster is able to make important inferences about the growth and development of existing phenomena. By looking at low- and mid-level reflectivities, for example, a forecaster can look for echo patterns that indicate the location of a storm's updraft and whether there is a vertical tilt (mid-level echo overhang) to the storm. This can help determine if the storm has or will become severe. Signatures in Doppler velocity patterns give the forecaster information about the horizontal wind field, making it possible to locate mesocyclones, areas of convergence or divergence, and tornado vortex signatures (TVSs). This information is crucial to the forecaster trying to decide if and when to issue a warning.

It is no surprise, then, that image products were so heavily used. They provide essential information to the forecaster that is not otherwise available. It is also obvious that the forecasts were not based on the information from the image products alone. The fact that the mesonet plot was the most often called product indicates that quantitative information is needed to verify the presence of the physical processes suggested by the imagery.

The product usage patterns of the RT83 experiment also suggest the need to consider data storage and processing requirements for future local-scale weather forecasting, operational or experimental. The science of meteorology and forecasting has always had extremely large requirements for data storage and processing. Where once the challenge was to process data from nationwide hourly surface observations and 12-hourly rawinsonde reports in an efficient and timely manner, today's computing capabilities make that a relatively simple task. Now, as the forecasting emphasis shifts to smaller scales of motion, the requirements for digital satellite and radar imagery increase and so does the need for greater computing resources. Consider that each image alone requires more storage space than that required to store a complete set of hourly surface observations for the entire country. Add to this a minimum requirement of two visible and two infrared satellite images every hour plus at least four radar images every hour, and it becomes quite apparent that the required computing resources are substantial. Mounting evidence suggests that far more frequent satellite imagery (rapid-scan data) would be very helpful, and 5-minute radar images are generally considered necessary for the warning problem. In short, the evolving forecasting data requirements bring with them substantial and increasing computing requirements; consideration of the one necessarily requires consideration of the other. It is evident that the meteorological community will continue to challenge, and be challenged by, computer resource limitations and communication technology for some time to come.

5. REFERENCES

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Schlatter, T. W., P. Schultz, and J. M. Brown, 1985: Forecasting convection with the PROFS system: comments on the summer 1983 experiment. Submitted to Bull. Am. Meteorol. Soc.

Table 1. Product Update Frequencies of Summer '83 Real-Time Exercise

National-Scale Products	Frequency
Infrared Satellite	60 min
500-mb Plot	12 h
700-mb Plot	12 h
300-mb Plot	12 h
400-mb Plot	12 h
250-mb Plot	12 h
200-mb Plot	12 h
150-mb Plot	12 h
850-mb Plot	12 h

NMC (AFOS) Products	
Radar Echoes	60 min
Mean Sea-Level Pressure Analysis	3 h
Weather Depiction	60 min
Surface Fronts	3 h
500-mb LFM Height Analysis	12 h
Radar Legends	60 min
500-mb LFM Vorticity Analysis	12 h
12-h LFM 500-mb Vorticity Forecast	12 h
12-h LFM 500-mb Height Forecast	12 h
12-h LFM Mean Sea-Level Pressure Forecast	12 h
700-mb LFM Height Analysis	12 h
Lifted Index Analysis	12 h
24-h Thunderstorm Probability Forecast	24 h
300-mb LFM Height Analysis	12 h
LFM Mean 1000-500-mb Rel Humid Analysis	12 h
12-h LFM Quantitative Precip Forecast	12 h
LFM 1000-500-mb Thickness Analysis	12 h
Lifted Index/K Index Plot	12 h
Precipitable Water Plot	12 h
24-h Severe Tstrm Cond Prob Forecast	24 h
300-mb LFM Isotach Analysis	12 h
Precipitable Water Analysis	12 h
12-h 700-mb LFM Vert Velocity Forecast	12 h
24-h LFM Mean Sea-Level Pressure Forecast	12 h
24-h 500-mb Vorticity Forecast	12 h
500-mb LFM Temperature Analysis	12 h
24-h LFM Quantitative Precip Forecast	12 h
700-mb LFM Temperature Analysis	12 h
12-h 700-mb LFM Height Forecast	12 h
24-h 500-mb LFM Height Forecast	12 h
12-h Mean 1000-500-mb Rel Hum LFM Forecast	12 h
200-mb LFM Height Analysis	12 h
Mean 1000-500-mb Rel Humidity Plot	12 h
LFM Mean Sea-Level Pressure Analysis	12 h

Table 1. Product Update Frequencies of Summer '83 Real-Time Exercise--continued

NMC (AFOS) Products--continued	Frequency
850-mb LFM Height Analysis	12 h
200-mb LFM Isotach Analysis	12 h
12-h LFM Lifted Index Forecast	12 h
24-h LFM 1000-500-mb Thickness Forecast	12 h
850-mb LFM Temperature Analysis	12 h
300-mb LFM Temperature Analysis	12 h
24-h 700-mb LFM Height Forecast	12 h
12-h LFM 1000-500-mb Thickness Forecast	12 h
12-h 850-mb LFM Temperature Forecast	12 h
24-h LFM Mean 1000-500-mb Rel Hum Forecast	12 h
24-h 700-mb LFM Vert Velocity Forecast	12 h
200-mb LFM Temperature Analysis	12 h
24-h 850-mb LFM Height Forecast	12 h
12-h 850-mb LFM Height Forecast	12 h
24-h 850-mb LFM Temperature Forecast	12 h
24-h Lifted Index Forecast	12 h
Regional-Scale Products	
Visible Satellite	30 min
SAO Combined Sfc Plot on Satellite	60 min
Infrared Satellite	30 min
Vis/IR Satellite Tint	30 min
SAO Station Names on Satellite	60 min
SAO Cur Sfc Wx on Satellite	60 min
SAO Sfc Temperature Plot on Satellite	60 min
SAO Sfc Streamlines on Satellite	60 min
SAO Sfc Dewpt Plot on Satellite	60 min
SAO Sfc Pressure Plot on Satellite	60 min
SAO Sfc Dewpoint Contours on Satellite	60 min
SAO Sfc Wind Barbs on Satellite	60 min
SAO Sfc Temp Contours on Satellite	60 min
SAO Sfc Pressure Contours on Satellite	60 min
Eastern Colorado-Scale Products	
Radar Mosaic Image	15 min
Visible Satellite	30 min
Lightning Plot	15 min
Surface Plot	60 min
Infrared Satellite	30 min
Sat/Radar Combo	30 min
SAO Sfc Streamlines	60 min
SAO Sfc Dewpoint Contours	60 min
SAO Sfc Temp Contours	60 min
SAO Sfc Pressure Contours	60 min

Table 1. Product Update Frequencies of Summer '83 Real-Time Exercise--continued

Eastern Colorado-Scale Products - continued	Frequency
County Map	
County Names Map	
County Seats Map	
SA Stations Names Map	
Local-Scale Products	
Mesonet Plot	5 min
Low-Level Radar Reflectivity	5 min
Radar Velocity	5 min
Mesonet Sky Params Plot	5 min
Lightning Plot	5 min
Mid-Level Radar Reflectivity	15 min
Mesonet Streamlines	5 min
Profiler Skew-T Plot	20 min
Rapid Scan Vis Satellite	5 min
Low-Lev Rad/Topo Combo	5 min
Denver Skew-T Plot	12 h
Radar Echo Tops	15 min
3-D Topography	
3.5-Deg Radar Ref	10 min
3.5-Deg Radar Velocity	10 min
Rapid Scan IR Satellite	5 min
Rivers map	
Drainage map	
Mesonet station names map	
Mesonet county map	
OTHER PRODUCTS	
UDD Plot	5 min

Table 2. Total Number of Product Calls Made During Summer '83 Real-Time Exercise

National-Scale Products	Total Calls
Infrared Satellite	331
500-mb Plot	34
700-mb Plot	25
300-mb Plot	18
400-mb Plot	18
250-mb Plot	13
200-mb Plot	13
150-mb Plot	11
850-mb Plot	11
	474
NMC (AFOS) Products	
Radar Echoes	113
Mean Sea-Level Pressure Analysis	82
Weather Depiction	72
Surface Fronts	66
500-mb LFM Height Analysis	53
Radar Legends	45
500-mb LFM Vorticity Analysis	41
12-h LFM 500-mb Vorticity Forecast	35
12-h LFM 500-mb Height Forecast	30
12-h LFM Mean Sea-Level Pressure Forecast	25
700-mb LFM Height Analysis	24
Lifted Index Analysis	24
24-h Thunderstorm Probability Forecast	23
300-mb LFM Height Analysis	23
LFM Mean 1000-500-mb Rel Humid Analysis	23
12-h LFM Quantitative Precip Forecast	22
LFM 1000-500-mb Thickness Analysis	21
Lifted Index/K Index Plot	21
Precipitable Water Plot	18
24-h Severe Tstrm Cond Prob Forecast	17
300-mb LFM Isotach Analysis	17
Precipitable Water Analysis	17
12-h 700-mb LFM Vert Velocity Forecast	15
24-h LFM Mean Sea-Level Pressure Forecast	14
24-h 500-mb Vorticity Forecast	14
500-mb LFM Temperature Analysis	13
24-h LFM Quantitative Precip Forecast	12
700-mb LFM Temperature Analysis	12
12-h 700-mb LFM Height Forecast	12

Table 2. Total Number of Product Calls Made During Summer '83 Real-Time Exercise--continued

NMC (AFOS) Products - continued	Total Calls
24-h 500-mb LFM Height Forecast	11
12-h Mean 1000-500-mb Rel Hum LFM Forecast	11
200-mb LFM Height Analysis	10
Mean 1000-500-mb Rel Humidity Plot	10
LFM Mean Sea-Level Pressure Analysis	9
850-mb LFM Height Analysis	8
200-mb LFM Isotach Analysis	7
12-h LFM Lifted Index Forecast	7
24-h LFM 1000-500-mb Thickness Forecast	7
850-mb LFM Temperature Analysis	6
300-mb LFM Temperature Analysis	5
24-h 700-mb LFM Height Forecast	5
12-h LFM 1000-500-mb Thickness Forecast	5
12-h 850-mb LFM Temperature Forecast	4
24-h LFM Mean 1000-500-mb Rel Hum Forecast	4
24-h 700-mb LFM Vert Velocity Forecast	3
200-mb LFM Temperature Analysis	2
24-h 850-mb LFM Height Forecast	2
12-h 850-mb LFM Height Forecast	1
24-h 850-mb LFM Temperature Forecast	1
24-h Lifted Index Forecast	1
	1023

Regional-Scale Products	
Visible Satellite	762
SAO Combined Sfc Plot on Satellite	311
Infrared Satellite	260
Vis/IR Satellite Tint	119
SAO Station Names on Satellite	98
SAO Cur Sfc Wx on Satellite	58
SAO Sfc Temperature Plot on Satellite	52
SAO Sfc Streamlines on Satellite	39
SAO Sfc Dewpt Plot on Satellite	37
SAO Sfc Pressure Plot on Satellite	32
SAO Sfc Dewpoint Contours on Satellite	31
SAO Sfc Wind Barbs on Satellite	30
SAO Sfc Temp Contours on Satellite	28
SAO Sfc Pressure Contours on Satellite	19
	1876

Table 2. Total Number of Product Calls Made During Summer '83 Real-Time Exercise--continued

Eastern Colorado-Scale Products	Total Calls
Radar Mosaic Image	1230
Visible Satellite	835
Lightning Plot	468
Surface Plot	401
Infrared Satellite	197
Sat/Radar Combo	174
SAO Sfc Streamlines	118
SAO Sfc Dewpoint Contours	74
SAO Sfc Temp Contours	60
SAO Sfc Pressure Contours	43
County map	8
County names map	5
County seats map	5
SA stations names map	5
	3623
Local-Scale Products	
Mesonet Plot	3150
Low-Level Radar Reflectivity	2731
Radar Velocity	1499
Mesonet Sky Params Plot	1030
Lightning Plot	863
Mid-Level Radar Reflectivity	688
Mesonet Streamlines	639
Profiler Skew-T Plot	500
Rapid Scan Vis Satellite	258
Low-Lev Rad/Topo Combo	235
Denver Skew-T Plot	212
Radar Echo Tops	161
3-D Topography	90
3.5-Deg Radar Ref	63
3.5-Deg Radar Velocity	48
Rapid Scan IR Satellite	39
Rivers map	35
Drainage map	12
Mesonet station names map	11
Mesonet county map	6
	12270
OTHER PRODUCTS	
UDD Plot	58
	58

Table 3. Products Most Often Called 10 Minutes Prior to Warning Issue Times

National-Scale Products	Number of Products
NMC (AFOS) Products	
12-h 700-mb LFM Height Forecast	2
Mean Sea-Level Pressure Analysis	2
Radar Echoes	2
LFM Mean 1000-500-mb Rel Humid Analysis	2
Regional-Scale Products	
Visible Satellite	9
SAO Combined Sfc Plot on Satellite	5
Vis/IR Satellite Tint	2
SAO Sfc Temperature Plot on Satellite	2
Eastern Colorado-Scale Products	
Radar Mosaic Image	33
Lightning Plot	18
Visible Satellite	17
Surface Plot	8
Infrared Satellite	6
Local-Scale Products	
Low-Lev Radar Reflectivity	157
Radar Velocity	114
Mesonet Plot	96
Mid-Level Radar Reflectivity	33
Lightning Plot	29

Table 4. Products Most Often Called 10 Minutes Prior to Issuing Precipitation and Wind Forecasts

<u>Precipitation</u>

National-Scale Products	Number of Calls
Infrared Satellite on National Scale	9
NMC (AFOS) Products	
Weather Depiction	6
Radar Echoes	3
Regional-Scale Products	
Visible Satellite on Region Scale	39
SAO Combined Sfc Plot on Satellite	26
Infrared Satellite on Region Scale	8
SAO Cur Sfc Wx on Satellite	6
Eastern Colorado-Scale Products	
Radar Mosaic Image	71
Visible Satellite on E. Colo Scale	48
Surface Plot on E. Colo Scale	38
Lightning Plot on E. Colo Scale	20
Local-Scale Products	
Mesonet Plot	271
Low-Lev Radar Refl on Local Scale	203
Radar Velocity on Local Scale	110
Mesonet Sky Params Plot	75
Lightning Plot on Local Scale	58
Mid-Level Radar Reflectivity	48
Mesonet Streamlines	39

Table 4. Products Most Often Called 10 Minutes Prior to Issuing Precipitation and Wind Forecasts--continued

Wind

National-Scale Products	Number of Calls
Infrared Satellite on National Scale	18
NMC (AFOS) Products	
Radar Echoes	9
500 mb LFM Height Analysis	4
500 mb LFM Vorticity Analysis	4
Weather Depiction	4
Regional-Scale Products	
Visible Satellite on Region Scale	57
SAO Combined Sfc Plot on Satellite	34
Infrared Satellite on Region Scale	16
Eastern Colorado-Scale Products	
Radar Mosaic Image	97
Visible Satellite on E. Colo Scale	77
Lightning Plot on E. Colo Scale	38
Surface Plot on E. Colo Scale	49
Local-Scale Products	
Mesonet Plot	257
Low-Lev Radar Refl on Local Scale	220
Radar Velocity on Local Scale	104
Mesonet Sky Params Plot	79
Lightning Plot on Local Scale	70
Mid-Level Radar Reflectivity	51
Mesonet Streamlines	46

Table 5: Products Most Often Called for Surveillance

	Number of Calls by Product	Total Calls per Scale
National-Scale Products		1363
Infrared Satellite	304	
NMC (AFOS) Products		
Radar Echoes	99	
Weather Depiction	62	
Regional-Scale Products		1608
Visible Satellite	657	
SAO Combined Sfc Plot on Satellite	246	
Infrared Satellite	236	
Eastern Colorado-Scale Products		2998
Radar Mosaic Image	1029	
Visible Satellite	693	
Lightning Plot	392	
Surface Plot	306	
Local-Scale Products		9950
Mesonet Plot	2526	
Low-level Radar Reflectivity	2151	
Mesonet Sky Parameters Plot	858	